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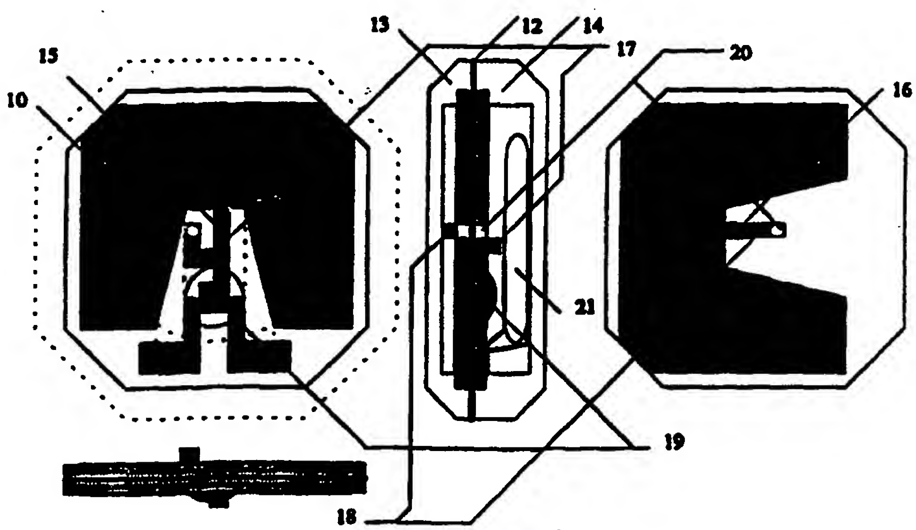

(57) Abstract

A microwave transponder for automatic identification systems using back scatter technology, where two parallel and concentric patch antennas with an intermediate earth plane are used to achieve good sensitivity from both sides.

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OMNIDIRECTIONAL TRANSPONDER

The present invention relates to a microwave transponder for automatic identification systems that have a back scatter function.

A back scatter system can be defined as a system in which the data carrier, the so-called transponder, includes antennas and modulation circuits that modulate information sidebands with the data to be read from a microwave signal falling on the transponder from a reading unit, therewith generating a reflected signal which contains information for reception and decoding by the reading unit, without supplying fresh energy. Certain embodiments also enable data to be written into the transponder, by modulating the amplitude of the signal from the reading unit with detection data, and memory programming in the transponder. This technique is well known and will not therefore be described in detail here.

One problem with microwave-based transponders of this kind, i.e. transponders that operate at 0.9 GHz and even higher frequencies, is that they are normally unable to communicate omnidirectionally, due to the directivity of the antenna system embodied in the transponder. This makes it necessary to orientate the transponder so that a given side of the transponder will face towards the reading unit, which is difficult to achieve when, e.g., the receiving unit is concealed in a package, a handbag, pocket or like receptacle.

Although the earth plane can be reduced to approximately the same size as the antenna plane with the aid of a patch antenna, so as to obtain equal sensitivity in both forward and rearward directions, transponder reading will then also become sensitive to reflections from a rearwardly lying reflection plane should this plane be located at a distance that causes leakage of the information carrying signal from the transponder antenna through the signal reflected via the reflection plane. Packaged objects contained in handbags and

the like are often reflective and cause uncertain readings. The same applies to the human body, when the transponder is carried in a pocket.

The necessity of taking into consideration the orientation of the data carrier and its proximity to surrounding objects in order to obtain positive readings is a troublesome limitation in each of these cases. Transponders equipped with dipolar antennas are subjected to corresponding problems, since these transponders are also influenced by the possible presence of a reflection plane in the proximity of the antenna.

Another drawback with antennas of this type is their low antenna gain, i.e. only a minor part of the incident signal is reflected back to the reading unit, due to lack of directivity, which shortens the range of the system.

The present invention fully solves these problems and provides a transponder that can be read from a short distance and from both sides of the antenna.

In accordance with one preferred embodiment, there is provided a transponder with which communication will not be disturbed by the presence of a rearwardly located reflection plane.

The present invention thus relates to a transponder which is adapted for use in automatic identifying systems and like systems, wherein the transponder includes a patch antenna which functions to reflect transponder data in the form of information sidebands to a microwave signal falling on the patch antenna and sent from a reading unit, and wherein the transponder is characterized in that it includes two mutually parallel but oppositely directed patch antennas.

In one preferred embodiment, the transponder obtains an almost fully isotropic function, that is to say it can be communicated with in all directions in the absence of the

troublesome neutral settings found, for instance, in the rod directions of dipoles. Corresponding blind directions are, of course, also found with patch antennas that have a small earth plane, since isotropic antennas are theoretically impossible.

In one particular embodiment of the invention, data can be written into the transponder, e.g., by coding amplitude modulation of the microwave signal, e.g. with a so-called Manchester code, with the data to be written. Such a bit stream in the form of an amplitude modulated microwave signal is captured by detection circuits in the transponder, rectified, amplified and caused to influence the memory register of the transponder.

The present invention employs two patch antennas that operate from respective sides of one and the same earth plane, or towards mutually separate earth planes that are separated solely by means of a thin foil, wherein in one preferred embodiment of the invention each of these two antennas is provided with an individual modulation circuit that is supplied from a common ASIC, in which the transponder data is stored. This antenna is turned towards the reading unit and reflects signals back to said unit with a directivity, or beaming effect, that provides a very good range.

This enables the transponder to be read from both directions. It also enables the transponder to be produced cheaply, e.g. by laminating the antenna in a known manner. Another advantage is that the ASIC, which is often the most expensive component of the transponder, is common to both antennas.

Accordingly, there are used two separate antennas which, in one preferred embodiment, are not mutually coupled by microwave techniques, but are, instead, mutually connected to respective modulation circuits by low-frequency signal conductors. Because no microwave connection is required

between the two antennas, the transponder can be manufactured much more simply.

In one particular embodiment, the transponder is communicated with circular-polarized microwaves, which further enhances the orientation tolerance. According to one preferred embodiment of the invention, one of the antennas may be turned through 90° when the transponders are linear-polarized and communicated with circular-polarized signals. This provides additional freedom on orientation, since only the E-field and not the H-field has neutral settings in a transponder with a small earth plane. The E-field and H-field from patch antennas with a small earth plane are disclosed in the literature, from which the effect referred to is clearly apparent.

The directional characteristic of the transponder is essentially the same irrespective of whether it is read or written, and consequently remarks concerning reading of the transponder will also apply to writing in the transponder.

With the intention of reducing the size of the transponder, its battery can be placed within the circle circumscribed by the patch antennas, instead of on one side thereof.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

- Fig. 1 is a block schematic illustrating two versions of the transponder;

- Fig. 2 illustrates a mechanical embodiment; and

- Fig. 3 illustrates another mechanical embodiment.

The transponder shown to the left of Fig. 1 differs from known transponders insomuch that electronics and memory

register 1 supply two patch antennas 2, 3 that are placed concentrically together, but with the antenna planes directed 180° from each other.

In the transponder to the left of Fig. 1, each of the antennas utilizes its modulation/detection circuits 4, 5, whereas the transponder shown to the right utilizes a common modulation/detection circuit 6. Both transponder types have principly the same function. The left-hand transponder is simpler to implement, but at the cost of an extra modulation element 4 or 5.

The technology of back scatter transponders is well known, with an incident microwave signal on which information sidebands are formed by virtue of the modulation components 4 and/or 5 periodically changing the antenna impedance in accordance with the data pattern from the memory register in block 1, such that the incident signal will be reflected in different ways depending on whether a zero or a one is outputted. The modulation components 4, 5, 6 will suitably comprise a diode, a field effect transistor or some other non-linear element that can be controlled from block 1.

When the transponder is a writable transponder, i.e. when data in the incident microwave signal can be written into the memory register in block 1, the modulation components 4 and 5 may consist of a diode. Separate components may alternative be used for detecting and modulation, although this technology is known and will not be discussed here.

Because the antennas 2 and 3 are each directed in a respective direction, the inventive transponder is able to reflect its information sideband, irrespective of whether the microwave signal from a reading unit falls from the right or the left in Fig. 1.

When the antennas have the form of patch antennas with a given directivity, i.e. their earth planes are made larger

than the antenna plane, the strength of the reflection will be stronger and the reading and/or writing range of the transponder longer.

Another advantage afforded by an earth plane that is larger than the antenna planes is that the transponder can be placed in the immediate proximity of a reflection plane without disturbing the function to any great extent. If this was not so, there is a danger that transponder communication will be uncertain when the transponder is placed, e.g., on or in the vicinity of a reflecting object in a bag or the like, due to the fact that the reflecting signal will be totally or partially extinguished by the signal reflected via the reflection plane.

Patch antennas that have small earth planes, i.e. with a lateral extension that lies between the own extension of the antenna element and its double-extension, have a directivity and back lobe that gradually transforms from a lobe breadth of about 90° and a very small back lobe to a lobe width of 360°, i.e. the back lobe is equally as large as the front lobe.

Of course, zero settings are found in a blind axis in all antennas, even if the earth plane is small. Otherwise, the antennas would be isotropic, which is a physical impossibility. These zero settings, however, only occur in an axis along the E-field of the antenna plane, while sensitivity is retained in all directions in the H-field of the antenna plane when the earth plane is small.

Consequently, the inventive embodiment illustrated in Fig. 2, in which the two antenna planes are rotated through 90° in relation to one another, provides a transponder that has an almost isotropic function. When reading is effected with a unit that is circular-polarized, so that it is able to irradiate and receive transponder information sidebands irrespective of the direction in which its linear-polarized

antenna is orientated, a highly effective omnidirectional transponder-reading has been achieved.

Because the earth plane is slightly greater than the antenna plane, the inventive transponder is relatively insensitive to being placed on a reflection plane, meaning that the back lobe from respective elements and its reflection in a rearwardly lying reflection plane will be moderate and in practice unharmful to the direct reflected wave.

Thus, in this embodiment of the invention, the size of the earth plane is adapted so that the transponder will not be sensitive to placement on reflection planes, whilst obtaining an almost isotropic function at the same time.

Fig. 2 thus shows the two antenna planes 10, 11 rotated through 90° in relation to one another in order to eliminate blind directions in accordance with the aforegoing. Each of the antennas acts against an earth plane 12, which may be common to both antennas or, for practical reasons, separated by a foil which may be conductive or insulating. This foil may be provided with an adhesive to enable the two covers 13, 14 of the transponder to be joined together.

There is nothing to prevent the earth planes 12 being separate planes, provided that they are not spaced too far apart, such as to disturb the function of respective antennas.

In another embodiment of the invention, not shown, antenna planes and earth planes are constructed in accordance with conventional multilayer techniques, with which the antenna planes are pressed onto both sides of an intermediate earth plane, and where a transit hole is provided for passing signal conductors and earth conductors between respective antenna sides.

In the case of the described example, the incident microwave signal is passed, via conductors 15, 16, to the modulation components, e.g. the diodes 17, 18, whose impedance varies in accordance with a pattern from the memory register in the circuit 19.

In the illustrated case, one of the modulation components is supplied via a low-frequency signal conductor 20 that connects one side of the antenna to the other side thereof. In another embodiment, not shown, this signal conductor may carry microwaves from one side to the other, so as to enable a common modulation component to be used.

When the transponder is powered by a battery 21, e.g. when it is not powered by microwaves or low-frequency electromagnetic fields, it can be positioned concentrically with the antennas and inwardly of the radiating edges of the antenna elements. The lateral extension of the transponder will therewith be smaller, without disturbing or impairing its function.

Fig. 3 illustrates an embodiment in which a battery 22 is positioned on one side of the antenna elements, so as to obtain a construction similar to a credit card. The solution and function in other respects are the same as that described with reference to Fig. 2. Transponder data is passed between the antennas via the intermediate connection 23, which may be a wire conductor as shown, or may be a penetrating-plating when the antennas have the form of multilayer cards.

Although the invention has been described with reference to various embodiments thereof, it will be understood by the person skilled in this art that the structural design of the transponders may be varied.

These illustrated embodiments do not therefore limit the scope of the present invention, since they can be modified within the scope of the following Claims.

CLAIMS

1. A transponder for use in automatic identification systems and corresponding systems, comprising a patch antenna which functions to reflect transponder data in the form of information sidebands of a microwave signal falling on the patch antenna from a reading unit, **characterized** in that the transponder includes two parallel but oppositely directed patch antennas (2, 3).

2. A transponder according to Claim 1, **characterized** in that each of the two patch antennas (2, 3) has a respective modulation and detection circuit (4, 5) that are controlled from a common ASIC (1) through a low-frequency signal conductor.

3. A transponder according to Claim 1 or 2, **characterized** in that the patch antennas (2, 3) act against one and the same earth plane (12) from opposite directions.

4. A transponder according to Claim 1 or 2, **characterized** in that each of the patch antennas (2, 3) acts against its respective earth plane (12), said earth planes being located close together.

5. A transponder according to Claim 1, 2, 3 or 4, **characterized** in that the patch antennas (2, 3) are linear polarized.

6. A transponder according to Claim 5, **characterized** in that the polarization direction of respective antennas (2, 3) is rotated through 90° in relation thereto.

7. A transponder according Claim 1, 2, 3, 4, 5 or 6, **characterized** in that the transponder is adapted to be read with a circular-polarized microwave signal from the reading unit.

8. A transponder according to any one of the preceding Claims, **characterized** in that the transponder comprises only one unit (1) that includes electronics and memory register to which modulation units (4, 5) that include modulation and detection circuits are connected, wherein respective patch antennas (2, 3) are each connected to a respective modulation unit (4, 5).

9. A transponder according to any one of Claims 1-7, **characterized** in that the transponder includes only one unit (1) that includes electronics and memory register; in that only one modulation unit (6) that contains modulation and detection circuits is connected to said unit (1); and in that both patch antennas (2, 3) are connected to said single modulation unit (6).

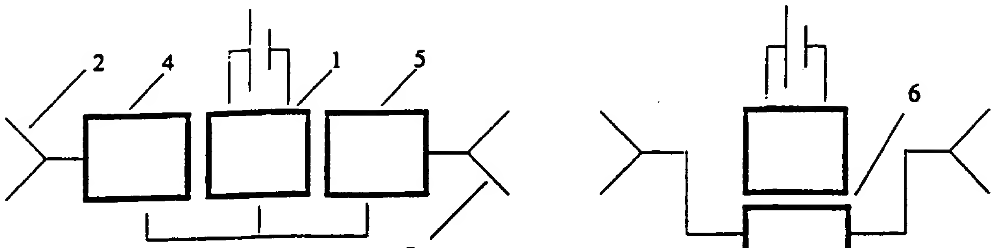

Fig 1

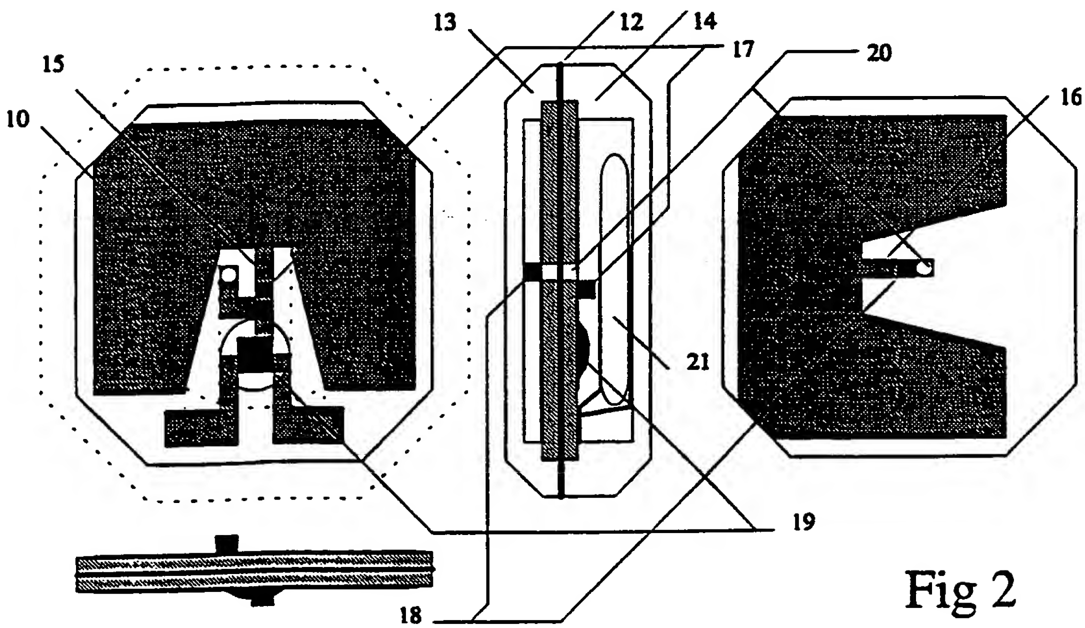

Fig 2

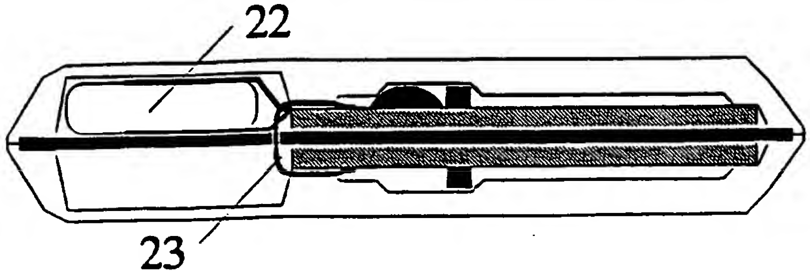

Fig 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/01931

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01S 13/74, G01S 13/80, H04B 1/59, H01Q 9/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01S, H04B, H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 April 1998	29.04.1998
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT
Information on patent family members

02/04/98

International application No.
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